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Australian — New Zealand Geodetic VLBI Network Project

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Abstract. Geodetic VLBI is a technique that maintains the International Celestial Reference Frame (ICRF) and contributes significantly to the International Terrestrial Reference Frame (ITRF) and Earth Orientation Parameter (EOP) service. Currently in Australia only the Hobart (Tasmania) radio telescope is involved in geodetic VLBI observations on a regular basis. A new VLBI network is planned which will consist of four new antennas (three Australian and one New Zealand), each comparatively small (12 meters in diameter) with fast slew rates (5 degrees per second in azimuth) equipped with Mark5B data recorders. All VLBI sites will be co-located with permanent GPS receivers, and some of them with SLR facilities to facilitate the frame-tie and verify the inter-technique performance. Computer simulation is presented which demonstrates that this network will have the potential to significantly improve the accuracy of the ICRF and hence of the ITRF in the Southern Hemisphere (to sub-mas and sub-cm levels, respectively). The first 12-m antenna of this series will be installed near Auckland, New Zealand in Aug. 2008.

1. Australian Network

National Collaborative Research Infrastructure Strategy (NCRIS) is a major initiative under the Government's Backing Australia's Ability — Building our Future through Science and Innovations. It aims to provide researchers with access to the infrastructure and networks necessary to undertake world-class research (http://www.ncris.dest.gov.au).

On Nov. 27, 2006 the Minister announced a funding allocation for twelve NCRIS priority areas. One of these twelve areas is "Structure and Evolution of the Australian Continent" which will help build an integrated national infrastructure system — AuScope. It has been awarded 42.8 million of Australian dollars, of which 15.4 million is committed to develop an enhanced national geospatial reference system.

The National Geospatial Reference System (NGRS) is a key element of the

AuScope providing a nationwide reference frame definition to support geodetic, seismic risk, neotectonic and geodynamics research, and also the basis for a wide range of spatial science applications.

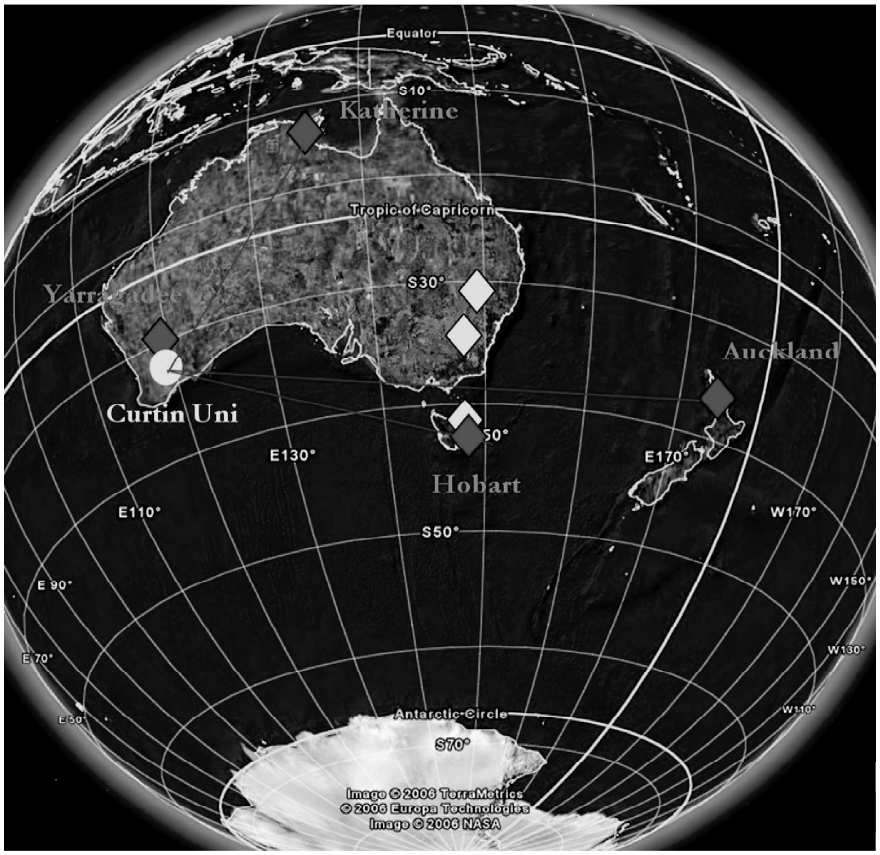

Figure 1. Location of the Australian and New Zealand radio telescopes

The AuScope proposal includes new VLBI sites at Yarragadee (Western Australia) and Katherine (Northern Territory) and a replacement of the Hobart (Tasmania) telescope. In addition, a software correlator system for correlation analysis of VLBI data will be developed at Curtin University within AuScope. In total 8.4 millions will be spent for VLBI infrastructure development in Australia including the correlator facility (6.7 within AuScope and 1.7 from other sources).

Fig. 1 shows the locations of the radio telescopes. They are separated by baselines of three–four thousand kilometers and produce a set of transcontinenal baselines ranging in length from three–eight thousand kilometers for Australian based radio telescopes.

Figure 2. 12-m dish "Patriot"

The 12-m fully steerable antenna (Fig. 2) was ordered from the "Patriot" manufacturers. Technical characteristics are in Tabl. 1.

Table 1. Technical specifications of the radio telescope

Diameter	12.1 m
Mount	Alt-Az
Surface accuracy	0.3 mm
F/D	0.375
Pointing accuracy	0.005 deg
Operation temperature	-15 to 55°C
Optics	Cassegrain with shaped primary and secondary reflectors
Frequency range	1.5–17 GHz
Slewing rate In azimuth In elevation	 5 deg/s 1.25 deg/s
Elevation limit	5 deg

We believe that the fast slew rate radio telescopes located in different parts of Australia and New Zealand will help to improve the geodetic positioning.

2. New Zealand Network

New Zealand, through the Institute for Radiophysics and Space Research (IRSR) at Auckland University of Technology (AUT), will operate a new geodetic VLBI 12-meter radio telescope near Warkworth (50 km north of Auckland), which is planned to be installed in Aug., 2008.

3. Simulations

Both Australia and New Zealand occupy a geographically strategic position for strengthening the global reference frame. Building new geodetic VLBI stations in Australia and New Zealand with fast slew rate antenna can provide a possibility for improving global reference frame accuracy.

Fig. 3 shows the improvement in vertical and horizontal components for Hobart site with respect to the existing Hobart 26-m radio telescope (slew rate 1 degree/second). The simulations have been done with a realistic schedule based on six existing telescopes in the Northern hemisphere, Hartrao (South Africa) plus a set of Australian and New Zealand sites. All components are expected to be improved by a factor of 3–4.

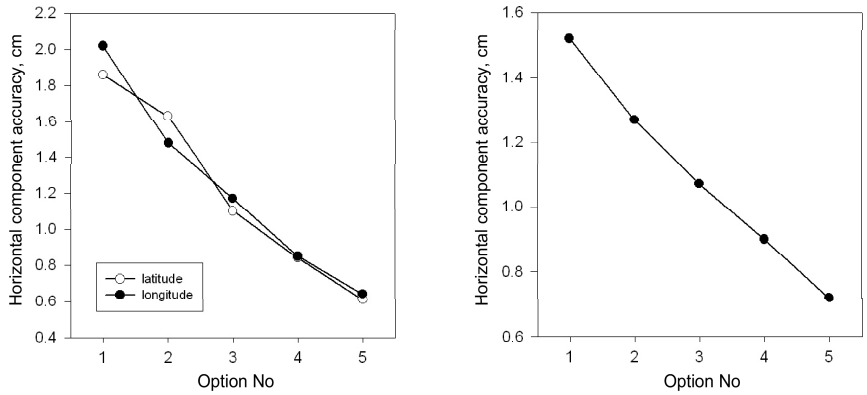

Figure 3. Improvement in horizontal and vertical accuracy for Hobart site with different options including six 'core' VLBI sites plus: 1 — the existing 26-meter Hobart dish; 2 — Hartrao and new Hobart dish; 3 — Hartrao, new Hobart and Yarragadee; 4 — Hartrao, new Hobart, Yarragadee and Katherine; 5 — Hartrao, new Hobart, Yarragadee, Katherine and Auckland

4. Data Correlation

A major requirement for VLBI data processing has been the correlation of interferometric signals received at the individual antennae. Until now this has been achieved by hardware correlators, and this has restricted the rates at which data can be collected. More recently, software correlators have been developed. This has led to a significant reduction in the cost of correlation. Coupled with the broadband network capabilities both in New Zealand (Kiwi Advanced Research and Education Network — KAREN) and Australia (AARNet), as well as with supercomputing capabilities both in Australia (Swinburne University of Technology, Curtin University of Technology and others) and in New Zealand (Blue Gene at University of Canterbury, New Zealand Supercomputing Centre in Wellington and others), it will permit Australia and New Zealand to perform near-real time analysis of the data collected under this programme.

Acknowledgements

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